OIPE JC139 NOV 15 2000 PATENT & TRADEMARK OFFICE

PCT$

525 Rec'd PCT/PTO 15 NOV 2000

**TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371**

ATTORNEY'S DOCKET NUMBER 0775/000003

U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/700367

| INTERNATIONAL APPLICATION NO. | INTERNATIONAL FILING DATE | PRIORITY DATE CLAIMED |
|---|---|---|
| **PCT/EP 99/03007** | **4 May 1999** | **15 May 1998**<br>5 February 1999 |

TITLE OF INVENTION: GAS-FLUIDIZED-BED REACTOR

APPLICANT(S) FOR DO/EO/US Rainer KARER, Kaspar EVERTZ, Wolfgang MICKLITZ, Hans-Jacob FEINDT, Philipp ROSENDORFER, Peter KOELLE

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. /X/ This is a FIRST submission of items concerning a filing under 35 U.S.C. 371.

2. / / This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371.

3. /X/ This express request to begin national examination procedures (35 U.S.C.371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).

4. /x/ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

5. /X/ A copy of the International Application as filed (35 U.S.C. 371(c)(2)).

   a./X/ is transmitted herewith (required only if not transmitted by the International Bureau).
   b./ / has been transmitted by the International Bureau.
   c./ / is not required, as the application was filed in the United States Receiving Office (RO/US0).

6. /X/ A translation of the International Application into English (35 U.S.C. 371(c)(2)).

7. /X/ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).

   a./X/ are transmitted herewith (required only if not transmitted by the International Bureau).
   b./ / have been transmitted by the International Bureau.
   c./ / have not been made; however, the time limit for making such amendments has NOT expired.
   d./ / have not been made and will not be made.

8. /X/ A translation of the amendments to the claims under PCT Article 19(35 U.S.C. 371(c)(3)).

9. /X/ An oath or declaration of the inventor(s)(35 U.S.C. 171(c)(4)).

10./ / A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11./X / An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

12./X / An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

13./ X / A FIRST preliminary amendment.
/ / A SECOND or SUBSEQUENT preliminary amendment.

14./ / A substitute specification.

15./ / A change of power of attorney and/or address letter.

16./x / Other items or information.
International Search Report
International Preliminary Examination Report

529 Rec'd PCT/PTC 15 NOV 2000

| U.S. Appln. No. (If Known) 09/700367 | INTERNATIONAL APPLN. NO. PCT/EP99/03007 | ATTORNEY'S DOCKET NO. 0775/000003 |
|---|---|---|

| 17. /X/ The following fees are submitted | CALCULATIONS | PTO USE ONLY |
|---|---|---|
| BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO.........................................$860.00 | **860.00** | |
| International preliminary examination fee paid to USPTO (37 CFR 1.482).......................................$750.00 | | |
| No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2))........................$700.00 | | |
| Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO ................$ 970.00 | | |
| International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied pro -visions of PCT Article 33(2)-(4)....................$96.00 | | |
| **ENTER APPROPRIATE BASIC FEE AMOUNT =** | $ 860.00 | |
| Surcharge of $130.00 for furnishing the oath or declaration later than / / 20 / /30 months from the earliest claimed priority date (37 CFR 1.492(e)). | | |

| Claims | Number Filed | | Number Extra | Rate | | |
|---|---|---|---|---|---|---|
| Total Claims | 15 | -20 | | X$18. | | |
| Indep.Claims | 1 | -3 | | X$80. | | |
| Multiple dependent claim(s)(if applicable) | | | +270. | | | |
| **TOTAL OF ABOVE CALCULATION** | | | | = | 860.00 | |
| Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28). | | | | | | |
| | | | **SUBTOTAL** | = | 860.00 | |
| Processing fee of $130. for furnishing the English translation later than / /20 / /30 months from the earliest claimed priority date (37 CFR 1.492(f)). | | | + | | | |
| **TOTAL NATIONAL FEE** | | | | = | **860.00** | |
| Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) $40.00 per property | | | = | | 40.00 | |
| **TOTAL FEES ENCLOSED** | | | | = $ | **900.00** | |
| | | | | Amount to be refunded: $ | | |
| | | | | Charged $ | | |

a./X/ A check in the amount of $ 900. to cover the above fees is enclosed.

b./ / Please charge my Deposit Account No.______ in the amount of $______ to cover the above fees. A duplicate copy of this sheet is enclosed.

c./X/ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **11-0345**. A duplicate copy of this sheetis enclosed.

**NOTE:** Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:
KEIL & WEINKAUF
1101 Connecticut Ave., N.W.
Washington, D. C. 20036

Herbert B Keil
SIGNATURE

Herbert B. Keil
NAME
Registration No. 18,967

09/700367
529 Rec'd PCT/PTC 15 NOV 2000

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of
KARER et al.

BOX PCT

International Application
PCT/EP 99/03007

Filed: May 15, 1999

For: GAS-PHASE FLUIDIZED-BED REACTOR

PRELIMINARY AMENDMENT

Honorable Commissioner of
Patents and Trademarks
Washington, D.C. 20231

Sir:

Prior to examination, kindly amend the above-identified application as follows:

IN THE CLAIMS

4. A reactor as claimed in [any of claims 1 to 3] claim 1, wherein flow reshapers are sited in the region of transition of the reaction gas from the circulation gas line into the reactor chamber in order to reshape the flow pulse of the incoming gas, said reshapers being arranged so as to bring about substantially homogeneous introduction of the gas flow into the fluidized bed.

5. A reactor as claimed in [any of claims 1 to 3] claim 1, wherein, in the region of transition of the reaction gas from the circulation gas line into the reactor chamber, for reshaping the flow pulse of the incoming gas, there is sited a wide-mesh grid on which balls are fixed in such number, size and distribution as to bring about substantially homogeneous introduction of the gas flow into the fluidized bed.

6. A reactor as claimed in [any of claims 1 to 5] claim 1, wherein the internal diameter of the reactor chamber (1) is more than 0.5 m.

7. A reactor as claimed in [any of claims 1 to 6] claim 1, wherein, to prevent the penetration of polymer particles into the circulation gas line when the compressor is switched off, a closable flap is sited in the region of transition from the circulation gas

line into the lower section of the reactor chamber.

9. A reactor as claimed in [any of claims 1 to 8] claim 1, wherein a calming zone (2) follows the upper section of the reactor chamber (1).

10. A reactor as claimed in [any of claims 1 to 9] claim 1, wherein between the reactor chamber (1) and the units of the circulation gas line there is sited a cyclone to separate off polymer and catalyst particles from the circulation gas.

11. A process for polymerizing ethylene or for copolymerizing ethylene with $C_3$- to $C_8$-α-olefins, wherein the (co)polymerization is conducted in a reactor as claimed in [any of claims 1 to 10] claim 1.

14. A process as claimed in [any of claims 11 to 13] claim 11, wherein to prepare a (co)polymer of a preselected density d the (co)polymerization is conducted at a temperature situated within a range bounded by an upper limit of equation (I)

$$T_H = 171 + \frac{6d'}{0.84-d'} \qquad \text{(I)}$$

and a lower limit of equation (II)

$$T_L = 173 + \frac{7.3d'}{0.837-d'} \qquad \text{(II)}$$

where

$T_H$ is the highest reaction temperature in °C

$T_L$ is the lowest reaction temperature in °C

d' is the numerical value of the density (d) [g/cm$^3$] of the (co)polymer to be prepared.

15. A process for preparing EPDM, wherein the copolymerization is conducted in a reactor as claimed in [any of claims 1 to 10] claim 1.

## REMARKS

The claims were amended in the preliminary examination. The claims have been amended further to eliminate multiple dependency and to put them in better form for U.S. filing. No new matter is included. A clean copy of the claims is attached.

Favorable action is solicited.

Respectfully submitted,

KEIL & WEINKAUF

Herbert B. Keil
Reg. No. 18,967

1101 Connecticut Ave., N.W.
Washington, D.C. 20036
(202)659-0100

1. A gas-phase fluidized-bed reactor for polymerizing ethylenically unsaturated monomers, comprising a reactor chamber (1) in the form of a vertical tube, a circulation gas line (3), a circulation gas compressor (4) and a cooling device (5), the circulation gas compressor (4) and the cooling device (5) being sited in the circulation gas line (3), wherein, in the region of transition of the reaction gas from the circulation gas line into the reactor chamber and in the lower section of the reactor chamber itself, there is either no gas distributor plate at all or only a gas distributor plate the total surface area of whose gas orifices is more than 20% of the total surface area of said gas distributor plate, and the gas-phase fluidized-bed reactor has no internal heat exchanger in the reactor chamber.

2. A reactor as claimed in claim 1, wherein there is no gas distributor plate in the region of transition of the reaction gas from the circulation gas line into the reactor chamber or in the lower section of the reactor chamber itself.

3. A reactor as claimed in claim 1, wherein, in the region of transition of the reaction gas from the circulation gas line into the reactor chamber or in the lower section of the reactor chamber itself, there is a gas distributor plate the total surface area of whose gas orifices is more than 90% of the total surface area of said gas distributor plate.

4. A reactor as claimed in in claim1, wherein flow reshapers are sited in the region of transition of the reaction gas from the circulation gas line into the reactor chamber in order to reshape the flow pulse of the incoming gas, said reshapers being arranged so as to bring about substantially homogeneous introduction of the gas flow into the fluidized bed.

5. A reactor as claimed in claim 1, wherein, in the region of transition of the reaction gas from the circulation gas line into the reactor chamber, for reshaping the flow pulse of the incoming gas, there is sited a wide-mesh grid on which balls are fixed in such number, size and distribution as to bring about substantially homogeneous introduction of the gas flow into the fluidized bed.

6. A reactor as claimed in in claim 1, wherein the internal diameter of the reactor chamber (1) is more than 0.5 m.

7. A reactor as claimed in claim 1, wherein, to prevent the penetration of polymer particles into the circulation gas line when the compressor is switched off, a closable flap is sited in the region of transition from the circulation gas line into the lower section of the reactor chamber.

8. A reactor as claimed in claim 7, wherein the closeable flap is provided with uniformly distributed holes having a diameter of between 1 and 7 mm.

9. A reactor as claimed in claim 1, wherein a calming zone (2) follows the upper section of the reactor chamber (1).

10. A reactor as claimed in claim 1, wherein between the reactor chamber (1) and the units of the circulation gas line there is sited a cyclone to separate off polymer and catalyst particles from the circulation gas.

11. A process for polymerizing ethylene or for copolymerizing ethylene with $C_3$- to $C_8$-α-olefins, wherein the (co)polymerization is conducted in a reactor as claimed in claim 1.

12. A process as claimed in claim 11, wherein polymerization is conducted in the presence of condensed monomers and/or condensed hydrocarbons.

13. A process as claimed in claim 11, wherein a mixture comprising gaseous and liquid monomers is fed into the reactor chamber.

14. A process as claimed in claim 11, wherein to prepare a (co)polymer of a preselected density d the (co)polymerization is conducted at a temperature situated within a range bounded by an upper limit of equation (I)

$$T_H = 171 + \frac{6d'}{0.84-d'} \qquad \text{(I)}$$

and a lower limit of equation (II)

$$T_L = 173 + \frac{7.3d'}{0.837-d'} \qquad \text{(II)}$$

where

$T_H$ is the highest reaction temperature in °C

$T_L$ is the lowest reaction temperature in °C

d' is the numerical value of the density (d) [g/cm$^3$] of the (co)polymer to be prepared.

15. A process for preparing EPDM, wherein the copolymerization is conducted in a reactor as claimed in claim 1.

1/PRTS

09/700367
529 Rec'd PCT/PTC 15 NOV 2000

Gas-phase fluidized-bed reactor

The present invention relates to a gas-phase fluidized-bed reactor for polymerizing ethylenically unsaturated monomers, comprising a reactor chamber (1) in the form of a vertical tube, if desired a calming zone (2) following the upper section of the reactor chamber, a circulation gas line (3), a circulation gas compressor (4) and a cooling device (5), wherein, in the region of transition of the reaction gas from the circulation gas line into the reactor chamber and in the lower section of the reactor chamber itself, there is either no gas distributor plate at all or only a gas distributor plate the total surface area of whose gas orifices is more than 20% of the total surface area of said gas distributor plate. The schematic construction of the reactor is shown in Figure 1. The invention also relates to processes for polymerizing ethylene or for copolymerizing ethylene with $C_3$- to $C_8$-$\alpha$-olefins and for preparing EPDM which are conducted in such a reactor.

Gas-phase polymerization processes are nowadays among the preferred processes for polymerizing ethylenically unsaturated monomers, especially ethylene, alone or in the presence of further unsaturated monomers. In this context, polymerization processes in fluidized beds are regarded as particularly economical.

Gas-phase fluidized-bed reactors for conducting such processes have long been known. The reactors which are common at present share numerous structural features: they consist, inter alia, of a reactor chamber in the form of a vertical tube whose upper section is usually of expanded diameter. Owing to the larger tube diameter in this calming zone there is a reduced gas flow, which limits the discharge of the fluidized bed consisting of small polymer particles. Furthermore, these reactors include a circulation gas line, which accommodates cooling units to dissipate the heat of polymerization, a compressor, and, if desired, further elements, such as a cyclone for removing fine polymer dust, for example. Examples of such gas-phase fluidized-bed reactors have been described, for example, in EP-A-0 202 076, EP-A-0 549 252 and EP-A-0 697 421.

All known gas-phase fluidized-bed reactors possess, in the lower section of the reaction chamber, a reactor plate which spatially closes off the reaction chamber from the circulation gas line and the gas distribution area. The function of this reactor plate is firstly to prevent the polymer particles flowing back into the

circulation gas pipe when the compressor is switched off. Secondly, the general technical teaching is that the pressure loss occurring at this reactor plate owing to the relatively narrow entry aperture ensures uniform distribution of gas in the reaction chamber. This taught opinion is expressed, for example, in US-A-3 298 792 and EP-A-0 697 421.

A reactor plate in the form that is nowadays customary, i.e., a narrow-mesh grid or a metal plate with narrow bores of various geometry, however, has a number of disadvantages: on both the side of the plate which confronts the flow and on the top side of the plate there may be continual instances of polymer deposition caused by dustlike polymer and catalyst particles which are entrained by the gas flow into the circulation gas line. This risk is increased in the case of what is known as condensed-mode operation: that is, when there are liquid monomers in the circulation gas. In addition to these deposits, which may lead to an increase in pressure and, ultimately, to a termination of the polymerization process, however, the pressure loss in normal operation also gives rise to additional energy costs, since the compressor has to compensate for this pressure loss by a higher output.

It is an object of the present invention to provide a gas-phase fluidized-bed reactor which no longer has these disadvantages.

We have found that this object is achieved by the gas-phase fluidized-bed reactor described at the outset and by processes for (co)polymerization in such a reactor.

The gas-phase fluidized-bed reactor of the invention is suitable in principle for polymerizing various ethylenically unsaturated monomers. Examples are ethylene, propylene, 1-butene, isobutene, 1-pentene, 1-hexene, 1-heptene, 1-octene and higher α-olefins, and also dienes such as butadiene and cyclopentadiene, and cycloolefins, such as cyclopentene and cyclohexene. The ethylenically unsaturated monomers can be polymerized alone or in a mixture. The reactor of the invention is particularly suitable for homopolymerizing ethylene, for preparing ethylene-hexene and ethylene-butene copolymers, and for preparing EPDM.

In a preferred embodiment of the gas-phase fluidized-bed reactor of the invention there is no gas distributor plate in the region of transition of the reaction gas from the circulation gas line into the reactor chamber or in the lower section of the reactor chamber itself.

Preference also attaches to a reactor in which, in the region of transition of the reaction gas from the circulation gas line into the reactor chamber or in the lower section of the reaction chamber itself, there is a gas distributor plate the total surface area of whose gas orifices is more than 50%, with particular preference more than 90%, of the total surface area of said gas distributor plate.

Where a reactor plate is done away with entirely, and also for the other plate constructions with very low pressure loss, flow reshapers should be sited at the point of transition of the circulation gas from the circulation gas line into the reaction chamber in order to reshape the flow pulse of the incoming gas, especially in the case of reactors of large dimension. This can be realized by means of various gas diversion devices, such as guide vanes, deflectors, impact plates or the like, as are familiar to the person skilled in the art.

Preference is given to gas-phase fluidized-bed reactors in which flow guide vanes are sited in the region of transition of the reaction gas from the circulation gas line into the reactor chamber in order to reshape the flow pulse of the incoming gas, said vanes being arranged so as to bring about substantially homogeneous introduction of the gas flow into the fluidized bed. The terms plate, deflector and vane as used herein do not of course imply the material from which the device is made but merely its form and function; the nature of the material is unimportant provided it is compatible with the polymerization conditions.

A further preferred apparatus for gas distribution on entry into the reaction chamber of the reactor of the invention consists of a wide-mesh grid which is sited in the region of transition of the reaction gas from the circulation gas line into the reactor chamber in order to reshape the flow pulse of the incoming gas and on which balls are fixed in such number, size and distribution as to bring about substantially homogeneous introduction of the gas flow into the fluidized bed. Said grid should be so wide-meshed that it causes virtually no pressure loss; the function of this grid is to hold the balls, which act as diverters or deflectors for the gas flow, in the desired position. The balls can be distributed uniformly over the grid. In the case of reactors of large diameter in particular, however, it may be sensible to dispose a greater number of such balls in the region of the reactor axis - that is, directly over the point

of inward flow of gas in the centre of the reactor cross section - than in the edge region.

Instead of the balls it is of course also possible to use other geometric structures; balls, however, are preferred since they bring about a particularly uniform and low-turbulence distribution of gas.

The gas-phase fluidized-bed reactors of the invention exhibit their advantageous properties in particular on the industrial scale. Preferred reactors in this context are those in which the internal diameter of the reaction chamber (1) is more than 0.5 m and, with particular preference, more than 1 mm. Particularly advantageous reactors are those having internal diameters of between 2 and 8 m.

To prevent relatively large amounts of solid entering the circulation gas system the reactor of the invention may be provided with various means of gas/solid separation. In one embodiment of the reactor of the invention, as already mentioned, a calming zone (2) follows the upper section of the reactor chamber (1). In another embodiment of the gas-phase fluidized-bed reactor of the invention, between the reactor chamber (1) and the units of the circulation gas line there is sited a cyclone to separate off polymer and catalyst particles from the circulation gas. If desired, this cyclone may also be combined with a calming zone (2). In another embodiment, there is no such calming zone, so that the circulation gas line and/or, additionally, a means of separating polymer and catalyst particles from the circulation gas, i.e., for example, a cyclone, ajoins the reactor chamber directly. For the case as well where the reactor comprises neither a calming zone nor any other means of separating circulation gas and solid, the term "reactor chamber" should be understood as meaning that in this part of the reactor essentially the polymerization takes place and parts of the polymer are circulated with the circulation gas only to a minor extent.

Since the reactors of the invention do not have a reactor plate which is able to prevent the flow of polymer particles back into the circulation gas line when the compressor is switched off, it may be judicious to take measures to prevent such flow. For example, a flap or a slide can be sited in the region of the outlet of the circulation gas line into the reaction chamber, and when the compressor is switched off and when, for example, the reactor is being filled prior to the beginning of polymerization said flap or slide can be closed but is opened when the

compressor is started up. A preferred embodiment of the invention envisages the closable flap or slide being provided with uniformly distributed holes having a diameter of preferably between 1 and 7 mm. With the aid of such a flap it is possible to fluidize the bed when the flap is closed at the beginning.

In accordance with the invention, the gas-phase fluidized-bed reactor described herein is particularly suitable for the implementation of processes for polymerizing ethylene or for copolymerizing ethylene with $C_3$- to $C_8$-$\alpha$-olefins as specified at the outset. Furthermore, a preferred process for preparing EPDM is that wherein the copolymerization is conducted in a reactor of the invention.

Since there is a limited risk, if any, of polymer deposits in the region of the reactor plate it is possible to dispense with numerous complex precautionary measures which are frequently taken when using conventional gas distribution plates. For example, the installation of a cyclone to separate off fine dust at the outlet from the reaction chamber is generally superfluous. It is also possible without problems to meter in liquid monomer, and to do so in a larger amount than is otherwise the case with the condensed mode of operation. Carrying out the process of the invention in the presence of condensed monomers is therefore particularly advantageous.

Accordingly, one advantageous embodiment of the process of the invention is that wherein a mixture comprising gaseous and liquid monomers is fed into the reactor chamber.

The polymerization process of the invention is carried out such that the polymerization takes place essentially in the reactor chamber (1) and only small amounts of particles circulate with the circulation gas. This can be achieved by means of the abovementioned means of gas/solid separation. Often, however, it is possible to do without such means to a very large extent, if the polymerization is conducted only just below the softening temperature of the polymers.

A preferred embodiment of the process of the invention is therefore that wherein to prepare a (co)polymer of a preselected density d the (co)polymerization is conducted at a temperature situated within a range bounded by an upper limit of equation (I)

$$T_H = 171 + \frac{6d'}{0.84-d'} \qquad (I)$$

and a lower limit of equation (II)

$$T_L = 173 + \frac{7.3d'}{0.837-d'} \qquad (II)$$

where

$T_H$ is the highest reaction temperature in °C

$T_L$ is the lowest reaction temperature in °C

$d'$ is the numerical value of the density (d) of the (co)polymer to be prepared.

This high-temperature mode of operation means that only a small proportion of fine dust occurs, so that separation of the solids is usually superfluous.

Example

In a fluidized-bed reactor according to Fig. 1 having a reaction chamber internal diameter of 0.5 m and a reaction chamber height of 3 m a flow reshaper was sited in the entry region of the reaction chamber. There was no gas distributor plate.

Copolymerization was carried out in this reactor under the following conditions:

| | |
|---|---|
| Gas composition: | 50% ethylene |
| | 45% nitrogen |
| | 5% 1-butene |
| Circulation gas rate: | 35 m/s |
| Temperature: | 115°C |
| Pressure: | 20 bar |

Polymerization was carried out continuously for 60 h. When the reactor was opened after polymerization, no lumps or deposits whatsoever were visible.

We claim:

1. A gas-phase fluidized-bed reactor for polymerizing ethylenically unsaturated monomers, comprising a reactor chamber (1) in the form of a vertical tube, a circulation gas line (3), a circulation gas compressor (4) and a cooling device (5), the circulation gas compressor (4) and the cooling device (5) being sited in the circulation gas line (3), wherein, in the region of transition of the reaction gas from the circulation gas line into the reactor chamber and in the lower section of the reactor chamber itself, there is either no gas distributor plate at all or only a gas distributor plate the total surface area of whose gas orifices is more than 20% of the total surface area of said gas distributor plate, and the gas-phase fluidized-bed reactor has no internal heat exchanger in the reactor chamber.

2. A reactor as claimed in claim 1, wherein there is no gas distributor plate in the region of transition of the reaction gas from the circulation gas line into the reactor chamber or in the lower section of the reactor chamber itself.

3. A reactor as claimed in claim 1, wherein, in the region of transition of the reaction gas from the circulation gas line into the reactor chamber or in the lower section of the reactor chamber itself, there is a gas distributor plate the total surface area of whose gas orifices is more than 90% of the total surface area of said gas distributor plate.

4. A reactor as claimed in any of claims 1 to 3, wherein flow reshapers are sited in the region of transition of the reaction gas from the circulation gas line into the reactor chamber in order to reshape the flow pulse of the incoming gas, said reshapers being arranged so as to bring about substantially homogeneous introduction of the gas flow into the fluidized bed.

5. A reactor as claimed in any of claims 1 to 3, wherein, in the region of transition of the reaction gas from the circulation gas line into the reactor chamber, for reshaping the flow pulse of the incoming gas, there is sited a wide-mesh grid on which balls are fixed in such number, size and distribution as to bring about substantially homogeneous introduction of

the gas flow into the fluidized bed.

6. A reactor as claimed in any of claims 1 to 5, wherein the internal diameter of the reactor chamber (1) is more than 0.5 m.

7. A reactor as claimed in any of claims 1 to 6, wherein, to prevent the penetration of polymer particles into the circulation gas line when the compressor is switched off, a closable flap is sited in the region of transition from the circulation gas line into the lower section of the reactor chamber.

8. A reactor as claimed in claim 7, wherein the closable flap is provided with uniformly distributed holes having a diameter of between 1 and 7 mm.

9. A reactor as claimed in any of claims 1 to 8, wherein a calming zone (2) follows the upper section of the reactor chamber (1).

10. A reactor as claimed in any of claims 1 to 9, wherein between the reactor chamber (1) and the units of the circulation gas line there is sited a cyclone to separate off polymer and catalyst particles from the circulation gas.

11. A process for polymerizing ethylene or for copolymerizing ethylene with $C_3$- to $C_8$-$\alpha$-olefins, wherein the (co)polymerization is conducted in a reactor as claimed in any of claims 1 to 10.

12. A process as claimed in claim 11, wherein polymerization is conducted in the presence of condensed monomers and/or condensed hydrocarbons.

13. A process as claimed in claim 11, wherein a mixture comprising gaseous and liquid monomers is fed into the reactor chamber.

14. A process as claimed in any of claims 11 to 13, wherein to prepare a (co)polymer of a preselected density d the (co)polymerization is conducted at a temperature situated within a range bounded by an upper limit of equation (I)

$$T_H = 171 + \frac{6d'}{0.84-d'} \qquad (I)$$

and a lower limit of equation (II)

$$T_L = 173 + \frac{7.3d'}{0.837-d'} \qquad (II)$$

where

$T_H$ is the highest reaction temperature in °C

$T_L$ is the lowest reaction temperature in °C

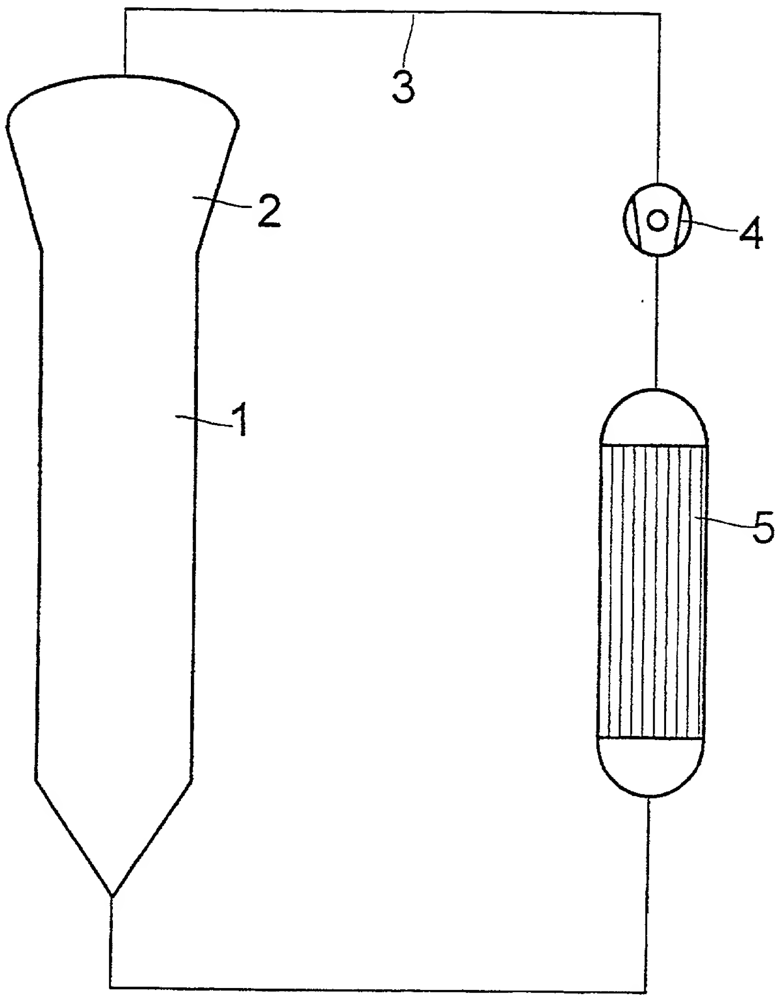
$d'$ is the numerical value of the density (d) [g/cm³] of the (co)polymer to be prepared.

15. A process for preparing EPDM, wherein the copolymerization is conducted in a reactor as claimed in any of claims 1 to 10.

# Gas-phase fluidized-bed reactor


## Abstract

Gas-phase fluidized-bed reactor for polymerizing ethylenically unsaturated monomers, comprising a reactor chamber (1) in the form of a vertical tube, if desired a calming zone (2) following the upper section of the reactor chamber, a circulation gas line (3), a circulation gas compressor (4) and a cooling device (5), where, in the region of transition of the reaction gas from the circulation gas line into the reactor chamber and in the lower section of the reactor chamber itself, there is either no gas distributor plate at all or only a gas distributor plate the total surface area of whose gas orifices is more than 20% of the total surface area of said gas distributor plate.


3
2
4
1
5

# *Declaration, Power of Attorney*



*0775/000003*

We (I), the undersigned inventor(s), hereby declare(s) that:

My residence, post office address and citizenship are as stated below next to my name,

We (I) believe that we are (I am) the original, first, and joint (sole) inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Gas-phase fluidized-bed reactor

the specification of which

[✓] is attached hereto.

[ ] was filed on ______________________________ as

Application Serial No. ______________________

and amended on ______________________________.

[x] was filed as PCT international application

Number *PCT/EP/99/03007*______________________

on *04 May 1999*______________________________

and was amended under PCT Article 19

on ______________________________ (if applicable).

We (I) hereby state that we (I) have reviewed and understand the contents of the above–identified specification, including the claims, as amended by any amendment referred to above.

We (I) acknowledge the duty to disclose information known to be material to the patentability of this application as defined in Section 1.56 of Title 37 Code of Federal Regulations.

We (I) hereby claim foreign priority benefits under 35 U.S.C. § 119(a)–(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed. Prior Foreign Application(s)

| **Application No.** | **Country** | **Day/Month/Year** | **Priority Claimed** | |
|---|---|---|---|---|
| *19821955.5* | *Germany* | *15 May 1998* | [x] Yes | [ ] No |
| *19904811.8* | *Germany* | *05 February 1999* | [x] Yes | [ ] No |

pduskpct001 - 25

We (I) hereby claim the benefit under Title 35, United States Codes, § 119(e) of any United States provisional application(s) listed below.

| (Application Number) | (Filing Date) |
|---|---|
| | |
| (Application Number) | (Filing Date) |

We (I) hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

| **Application Serial No.** | **Filing Date** | **Status (pending, patented, abandoned)** |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

And we (I) hereby appoint **Messrs. HERBERT. B. KEIL**, Registration Number 18,967; and **RUSSEL E. WEINKAUF**, Registration Number 18,495; the address of both being Messrs. Keil & Weinkauf, 1101 Connecticut Ave., N.W., Washington, D.C. 20036 (telephone 202–659–0100), our attorneys, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to sign the drawings, to receive the patent, and to transact all business in the Patent Office connected therewith.

We (I) declare that all statements made herein of our (my) own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

100 *Rainer Karer*
NAME OF INVENTOR

Rainer Karer

Signature of Inventor

Date June 2, 1999

*Marienburger Str.8*
*67659 Kaiserslautern* DEX
*Germany*
*Citizen of: Germany*
Post Office Address: same as residence

---

200 *Kaspar Evertz*
NAME OF INVENTOR

Kaspar Evertz

Signature of Inventor

Date May 20, 1999

*Stettiner Str.13*
*67105 Schifferstadt* DEX
*Germany*
*Citizen of: Germany*
Post Office Address: same as residence

---

300 *Wolfgang Micklitz*
NAME OF INVENTOR

Wolfgang Micklitz

Signature of Inventor

Date June 2, 1999

*Maconring 22* DEX
*67434 Neustadt*
*Germany*
*Citizen of: Germany*
Post Office Address: same as residence

~~Hans Jacob Feindt~~

---

400 *Hans–Jacob Feindt*
NAME OF INVENTOR

Hans Jacob Feindt

Signature of Inventor

Date May 20, 1999

*10 Sugar Maple Lane*
*Raritan Township, NJ 0882* NJ
*United States of America*
*Citizen of: Germany*
Post Office Address: same as residence

---

pduskpct001 - 25

500 *Philipp Rosendorfer*
NAME OF INVENTOR

Philipp Rosendorfer

Signature of Inventor

Date June 2, 1999

*Karolinenstr. 50*
*67434 Neustadt* DEY
*Germany*
*Citizen of: Germany*
Post Office Address: same as residence

---

600 *Peter Kölle*
NAME OF INVENTOR

Peter Kölle

Signature of Inventor

Date May 20, 1999

*Auf dem Köppel 2/11*
*67098 Bad Dürkheim* DEX
*Germany*
*Citizen of: Germany*
Post Office Address: same as residence